Malignant tumors of larynx

By

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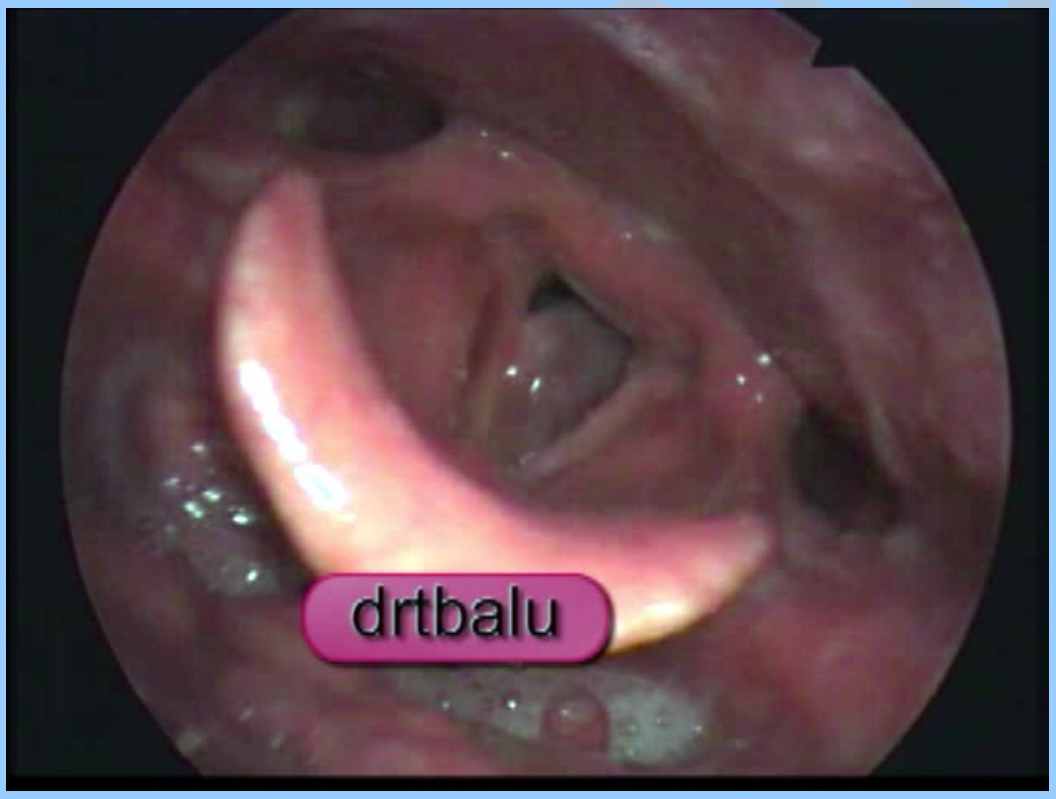

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Applied anatomy of larynx:

Larynx has been subdivided into three portions. This really helps

1. **In the classification of tumors**
2. **Deciding the treatment modality of the same**
3. **In determining the prognosis of the disease.**

Larynx has been subdivided into three anatomic regions:

1. **Supraglottis – The portion of larynx lying above the level of vocal folds**
2. **Glottis – This includes the portion of larynx that lie between the vocal folds**
3. **Subglottis – This includes the portion of larynx lying below the level of vocal folds.**

These laryngeal divisions form the basis of the currently used classification and staging of laryngeal malignancies.

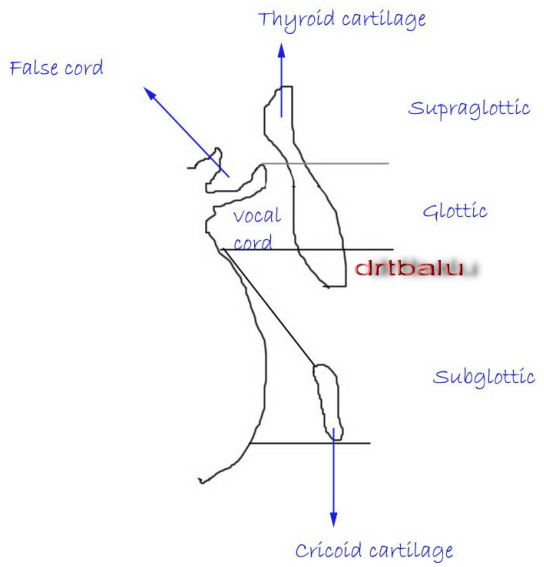

Figure showing the laryngeal anatomical divisions

- **Tumors arising from the true vocal cords including the commissures are considered glottic tumors.**
- **Tumors arising from the false cords, arytenoids, epiglottis and aryepiglottic folds are considered supraglottic tumors.**
- **Subglottic tumors are those that arise from the mucosa beginning 1 cm below the apex of the ventricle and extending up to the lower border of the Cricoid cartilage.**
- **Tumors arising from the tongue base and valleculae are considered to be oropharyngeal lesions and not laryngeal.**
- **The term "Marginal zone" is used to designate the area of difficulty.**
- **There is lack of a precise definition of "vocal cord". This grey area undermines the credibility of the TNM system of tumor classification.**

Tumor classifications like International Union Against Cancer (UICC) and American Joint Committee on Cancer (AJCC) make use of this anatomical division. These anatomical classifications allow comparisons to be made between various treatment centers in terms of site of tumor origin, extent of the disease, and the outcome of various forms of therapy for similar lesions.

Incidence of laryngeal malignancy:

Carcinoma larynx is the most common head and neck cancer worldwide. With the increasing life expectancy, and raised standards of living there has been a steady increase in the incidence of laryngeal cancer. World wide statistics put the incidence of cancer larynx between 1 – 2% of all cancers. It is 4 times more common in males when compared to females of the same age group. With increasing female population taking up to smoking this statistics is steadily changing.
Laryngeal cancers are more prevalent in the 6^{th} and 7^{th} decades of life.
People belonging to lower socio economic status have increased incidence of supra glottic carcinoma.
Glottic cancers make up for 59% of laryngeal malignancies.
Supra glottic cancers make up for 40% of laryngeal malignancies.
Subglottic malignancy is pretty rare i.e. less than 1%. This area is commonly involved as an extension from glottic cancers.
Incidence of laryngeal cancers is more in people living in urban environment because of increased use of tobacco in urban dwellers.

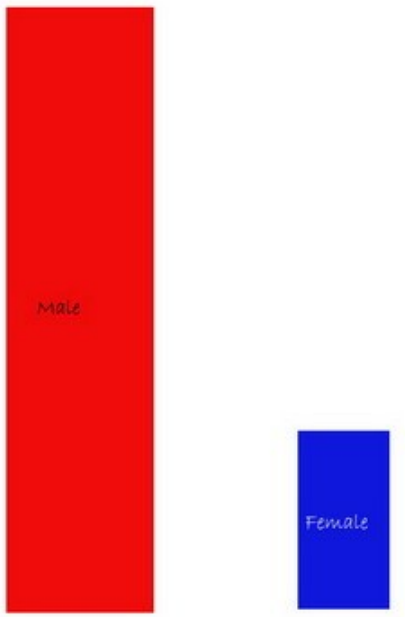

Figure showing incidence of laryngeal cancers in male and female

In North America and European countries glottic carcinoma accounts for 60 – 75% if all laryngeal malignancies, supraglottic carcinoma for 25% - 40% and Subglottic carcinoma accounting for the remaining 1 – 5%. Ironically in Finland this ratio is reversed with supraglottic cancers accounting for nearly 2/3 of all laryngeal malignancies. This difference in incidence is definitely related to the differences in exposure rates to carcinogens and co carcinogens in the environment.

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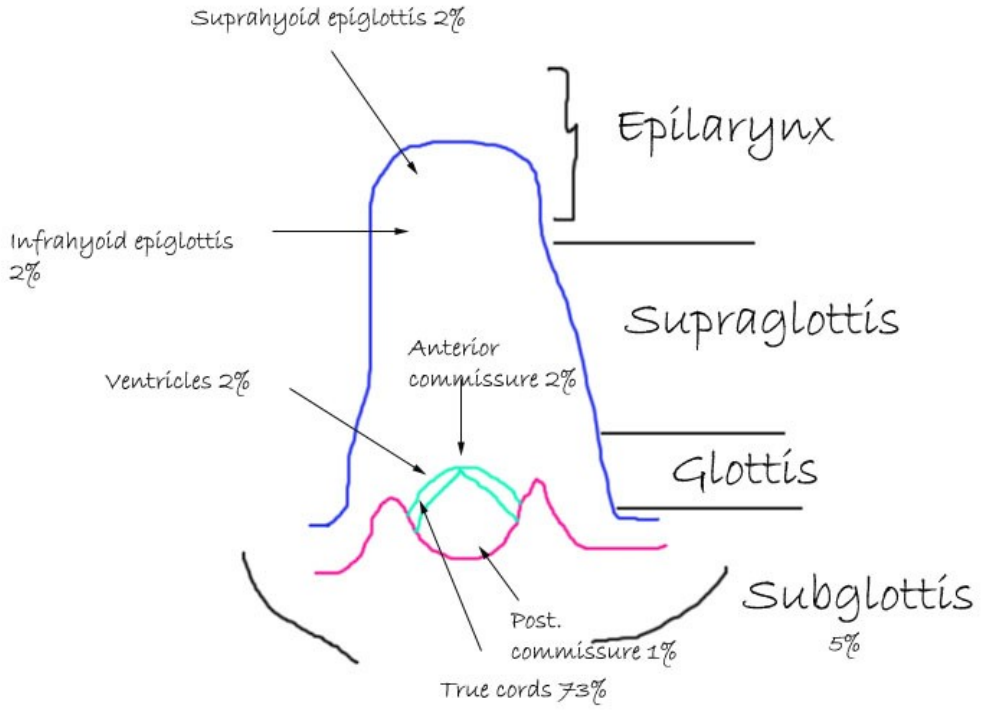


Diagram showing predilection rates of malignancy in various sites of larynx

Etiology:

It has been established that smoking and consumption of alcohol are potent risk factors responsible for laryngeal malignancy. Tobacco itself is a more potent risk factor than alcohol. Both these insults when combined increase the risk of malignancy by nearly 4 times.

Tobacco and Alcohol: These two substances have been proved to play a role in the etiology of Head and Neck malignancies. Of these two substances tobacco undoubtedly plays a vital role in the etiology of squamous cell cancers of head and neck region. Positive association also exists between tobacco usage and malignancy of upper aerodigestive tracts like oesophagus and lungs.

Studies have shown that concomitant exposure to tobacco and alcohol increased the risk of Head and neck malignancy by 4 times. The risk also increases proportionally as the number of cigarettes smoked per day increases. Cessation of smoking led to a

reduction in the incidence of malignancy in the head and neck region. The type of tobacco used also plays a vital role in the pathogenesis of malignancy. Air processed dark tobacco increases the risk of malignancy by 2 - 5 times when compared to light colored tobacco.

Role played by tobacco as a carcinogen: Tobacco smoke contains about 4000 different chemicals in different proportions. Out of these about 43 have been positively identified as carcinogens. These include:

1. Polycyclic hydrocarbons

2. Nitrosamines

3. Radio active polonium - 210

It has been demonstrated that there is a risk between the Head and neck squamous cell carcinoma subsite and the method of tobacco use (i.e. smoking, chewing and reverse smoking). Tobacco chewing increased the risk of oral cavity malignancy, while reverse smoking increased the risk of palatal malignancies.

Cannabis smoking has a greater risk of causing head and neck malignancy than smoking tobacco. This could be due to the higher concentration of coal tar and aromatic hydrocarbons when compared to tobacco smoke.

Alcohol (ethanol) is not a carcinogen perse. In combination with tobacco it potentiates the carcinogenic effects of chemicals found in tobacco. This can be attributed to the fact that alcohol is a potent solvent, and it dissolves the carcinogens released from tobacco making it easier to penetrate the body tissues. Ethanol also interferes with synthesis of retenoids, derivatives of vitamin A, the substances which are supposed to have a protective influence against the development of cancer.

Among alcohols Beer is supposed to contain nitrosamines a potent proven carcinogen. On the contrary wine is supposed to contain resveratrol which is a proven cancer chemo protective agent. So the type of alcohol consumed also has a role to play in the development of head and neck cancers. Drinkers of red wine have reduced incidence of head and neck malignancy than even teetotalers.

Viruses: Human papilloma virus has been believed to play a role in the aetiology of head and neck cancers. The genotypes of HPV (Human papilloma virus) have been classified in to three categories (risk wise).

1. High risk: (Types 16, 18)

2. Medium: (Types 31, 33)

3. Low: (Types 6, 11)

Infact the adult type of respiratory papillomatosis is caused by low risk HPV genotype, and hence is rarely associated with malignant transformation, where as the juvenile type of respiratory papillomatosis is caused by high risk HPV genotype. Malignant transformation is common in this group.

PCR studies have isolated DNA of high risk HPV types (types 16, 18) from head and neck tumors. Highest correlation could be found in malignant tissues from oral cavity.

Another virus which has a proven etiological role in causing head and neck malignancy is Ebstein Barr virus. This virus has been clearly shown to the cause for nasopharyngeal carcinomas. Patients with nasopharyngeal carcinoma show increased titres of Ebstein Barr virus antibodies.

Environmental factors:

Sunlight: Exposure to sunlight which contains ultraviolet rays can cause development of squamous cell carcinoma of skin and lips. It can also cause development of melanoma.

Occupational factors:

Nickel and chromium refining workers who are constantly exposed to these materials have an increased incidence of laryngeal cancers. Similarly exposure to asbestos fibres has also shown to play a role in aetiopathogenesis of head and neck malignancies.

Dietary factors: are also known to play a role in the etiopathogenesis of head and neck malignancies. The classic disorder being the Patterson Brown Kelly syndrome which is characterized by iron deficiency anemia, glossitis, koilonychia, and upper oesophageal webs carrying with it a high risk of post cricoid malignancy. The risk diminishes when the patient is nutritionally supported with iron and B complex supplements.

The association between nasopharyngeal carcinoma and salted fish diet has been documented. The traditional salted fish prepared in southern china contain volatile carcinogens like N-nitrosodimethylamine and N-nitrosodiehtylamine. Both these chemicals have been shown to be carcinogenic in nature.

The association of laryngopharyngeal reflux and laryngeal cancers is still being studied. The final word is not yet out at the time of writing this article.

Genetic causes: The development of head and neck cancers involves loss of control over cell proliferation and cell death. In fact there is no control at all. This loss of control at least partly has been attributed to be faulty genes. The regulation of growth and proliferation of all the cell types in the body is known to be controlled

by 40 known proteins that regulate the cell cycle. These regulator proteins are known to be products of proto oncogenes and tumor suppressor genes. Under normal conditions these genes work in a coordinated manner creating a balance between cell proliferation and cell death.

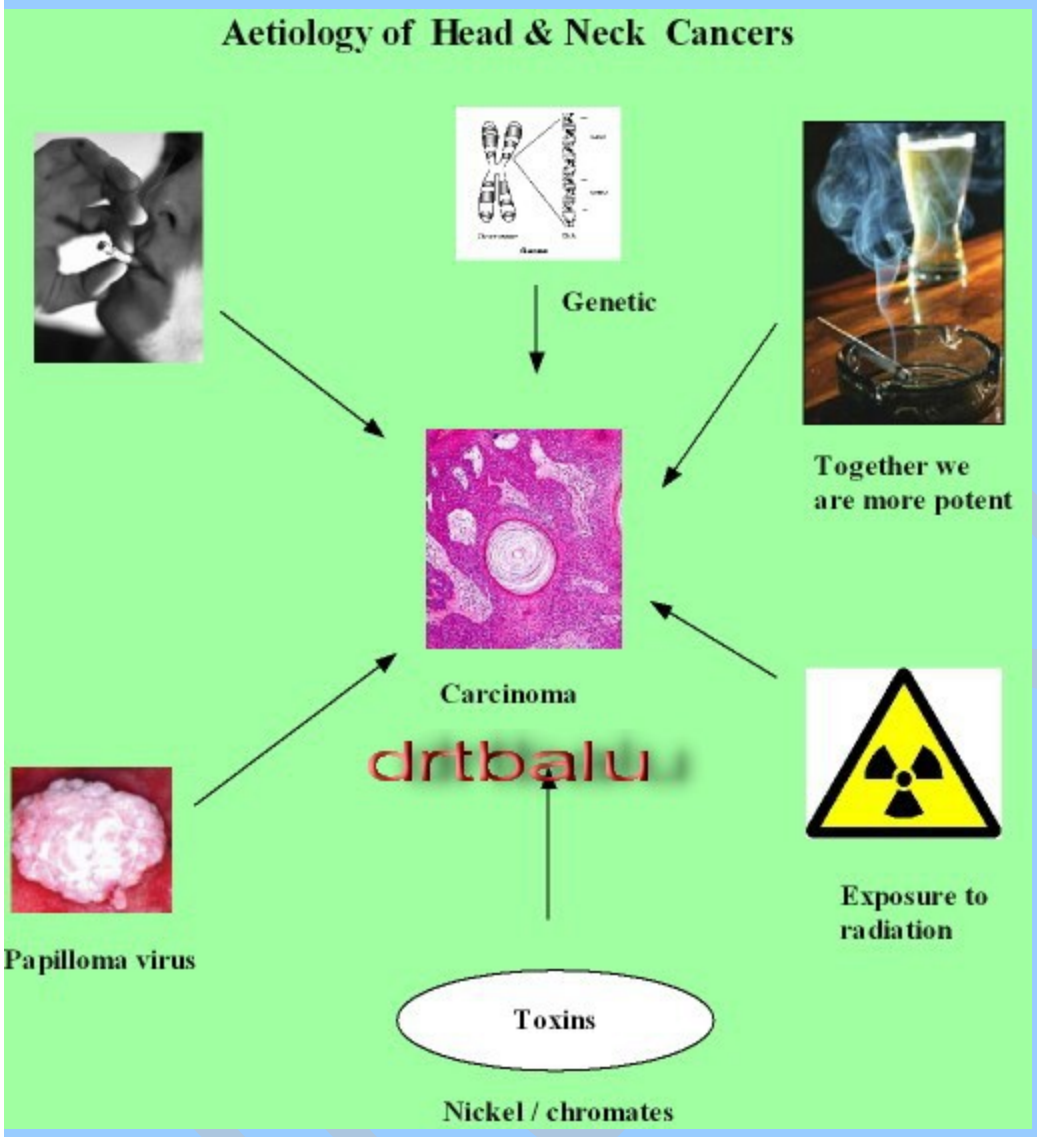
Mutations of these genes may cause abnormal protooncogene activation and tumor suppresor gene inactivation causing this balance to go hayware. These mutations could be point mutations, deletions, amplification of segments of DNA, and chromosomal rearrangements.

Familial predisposition: Head and neck cancers are preventable to a great extent, if only smokers and alcoholics decide to abstain. Studies have shown hereditary predisposition for head and neck malignancies. This could be due to the way in which the carcinogens are being detoxified in these individuals. Majority of ingested carcinogens are not dangerous themselves. It is only their intermediate metabolites which are released during the detoxification process which cause the damage.

Detoxification of these carcinogenic intermediaries requires an efficient enzyme system. If a particular toxic intermediary is allowed to accumulate due to some deficiency / defect in the detoxifying enzyme system it could cause irreparable damage to the system. These active metabolites (toxic intermediaries) can bind covalently to DNA causing genetic mutations.

Polymorphism: is defined as the presence of subtly different versions of one enzyme in different individuals. Polymorphism of the enzymes involved in the metabolism of carcinogens can cause detoxification problems. One enzyme which has been extensively studied for polymorphism is N-acetyltransferase 1. This enzyme is responsible for acetylating a variety of carcinogenic aromatic amines. A variety of polymorphic genotypes of this enzyme has been identified with varying degrees of efficiency. Less efficient the enzyme more is the risk for head and neck cancer. Another enzyme studied is Glutathione S-transferase. Four different familes of this enzyme has been identified with varying efficiencies (alpha, M, P and T).

Radiation exposure: Exposure to radiation can predispose head and neck cancers due to point mutations caused by it. Formerly radiation was used to treat tuberculosis of lymph nodes of neck. Patients who completed this course of treatment developed head and neck malignancy at a later date.



Molecular biology:

Genetic factors / mutations involved in the multifactorial etiology of laryngeal malignancy include:

- **Deletions of chromosomes 3p and 18q**
- **Amplification and overexpression of epidermal growth factor gene (c-crb-B)**
- **Amplification of int – 2, bcl-1 and other oncogenes have been found in some laryngeal carcinomas**
- **Gene products of N-ras, $p21^{N\text{-}ras}$ is over expressed in laryngeal carcinoma**
- **60% of laryngeal squamous cell carcinomas demonstrate mutations of p53 gene.**
- **Human papilloma virus genes have been demonstrated in 15% of patients with squamous cell carcinoma of larynx**
- **Amplification of 11q 13 region is one of the frequent aberration seen in patients with squamous cell carcinoma of larynx. This aberration has also been commonly associated with lymph node metastasis.**
- **11q 13 region has been known to codify cyclin D1 and cortactin genes.**
- **Suppression of p53 tumor suppression gene. This gene has been mapped in chromosome 17. Inside the cell, p53 protein binds DNA, which in turn stimulates another gene to produce a protein called p21 that interacts with a cell division-stimulating protein (cdk2). When p21 is complexed with cdk2 the cell cannot pass through to the next stage of cell division. Mutant p53 can no longer bind DNA in an effective way, and as a consequence the p21 protein is not made available to act as the 'stop signal' for cell division. Thus cells divide uncontrollably, and form tumors.**

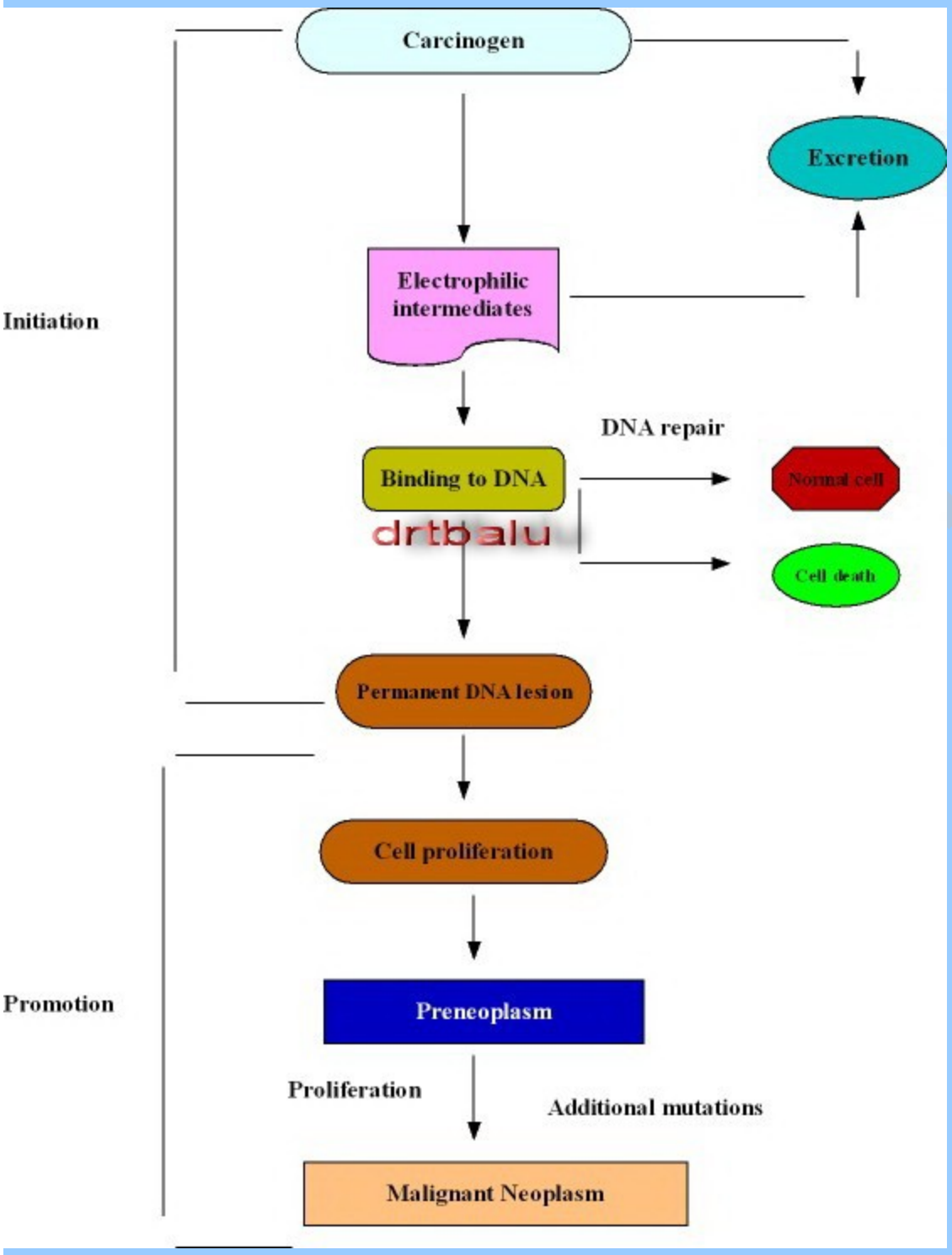


Figure showing the effects of carcinogen

Functions of larynx:

- **Maintaining airway**
- **Vocalization**
- **Protection of lower airways and lungs from toxins and toxic fumes**
- **Protection of lower airway from aspiration**
- **Acts as leverage during valsalva maneuvers**

Premalignant lesions of larynx:

If these lesions involve the vocal cords they become symptomatic very early during its evolution. Even minimal alteration in the vocal cord mucosa usually causes hoarseness of voice thus making early diagnosis feasible. This is hence the reason for better prognosis of vocal cord malignancies. Premalignant lesions involving the pyriform fossa may be totally asymptomatic or may cause negligible symptoms till they become too advanced. Infact early lesions involving the pyriform fossa and post Cricoid region may initially present only with a sticky sensation in the throat. Persistent hoarseness of voice should always be viewed with caution.

It has been demonstrated that when laryngeal mucosa is subjected to an irritating substance i.e. cigarette smoke / vocal cord trauma due to voice abuse it responds by first becoming tougher (squamous metaplasia). This is caused by increase in the thickness of the mucosa (acanthosis or squamous hyperplasia) or by production of keratin layer on the surface (keratosis). If this irritating substance contains a carcinogen, these protective changes may be accompanied by epithelial atypia or dysplasia.

Leukoplakia: Most typical mucosal lesions in the larynx take the form of thickened mucosa associated with keratosis. This process produces a white patch known as leukoplakia. Sometimes these leukoplakic patches appear as a reddish velvety patch known as *erythroplakia*. Keratosis of laryngeal mucosa is commonly caused by smoking cigarettes. In fact there is a correlation between the number of cigarette smoked and the presence of laryngeal keratosis and dysplasia.

Keratosis: Is defined as epithelial hyperplasia with an orderly maturation pattern. The cellular elements are normal in their appearance and architecture. They demonstrate some degree of surface keratinization which could be either orthokeratotic (formation of anuclear keratin layer) or parakeratotic (persistence of nuclei in keratinocytes) in nature.

Keratosis with atypia: In this condition keratosis is associated with some degree of cellular atypia / disturbance of maturation sequence. This can be graded into mild, moderate or severe. Both keratosis and keratosis with atypia are considered non malignant lesions; keratosis with atypia is more frequently associated with the later development of carcinoma.

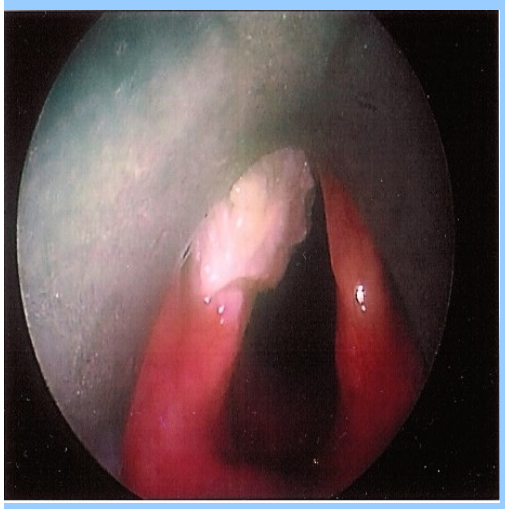


Figure showing keratosis involving vocal cord

Carcinoma in situ: is defined as a disorder of the epithelium in which all the generally accepted cytologic criteria of malignancy are manifest except invasion beyond the confines of basement membrane. There is full thickness epithelial involvement by atypical cells with loss of normal cell maturation, loss of polarity, hypercellularity, nuclear enlargement, increased mitotic activity and atypical mitotic figures.

Carcinoma in situ with microinvasion: In this condition the cells more or less resemble carcinoma in situ, but there is violation of basement membrane with histologic evidence of early invasion into the stroma.

WHO classification of Premalignant / Early malignant lesions:

- **Hyperplasia**
- **Keratosis**
- **Mild dysplasia**
- **Moderate dysplasia**
- **Severe dysplasia**
- **Carcinoma in situ**

Crissman's classification of premalignant laryngeal lesions:

Crissman etal recommended a classification system analogous to that used in the uterine cervix for cervical intraepithelial neoplasia. He used the term laryngeal intraepithelial neoplasia (LIN).
LIN I: Mild dysplasia (and keratosis)
LIN II: Moderate dysplasia (and intracellular dyskeratosis)

LIN III: Severe dysplasia and carcinoma in situ

It is really difficult to predict the biologic behavior of these lesions based on cellular morphology alone. Aneuploidy has been taken as an important factor in differentiating lesions that could potentially turn malignant. About 30% of these premalignant lesions may turn frankly malignant.

Growth pattern and spread of laryngeal carcinoma:

Understanding the complex anatomy and embryology is vital in the study of growth pattern and spread of laryngeal malignancies. The growth and spread of laryngeal carcinoma is determined by the site of origin of the primary tumor. One of the major factors in determining the direction and extent of tumor growth is the presence of anatomic barriers produced by laryngeal compartments.

Natural barriers of larynx involved in preventing tumor spread:

1. **Perichondrium covering the laryngeal cartilages**
2. **Endo laryngeal ligaments and membranes**
3. **Anterior commissure tendon prevents growth from spreading from one cord to the other.**

It is only when these barriers are breached does the tumor manage to spread to other areas of larynx.
Embryologically, supraglottic structures have a distinctly different origin than glottic structures. Glottis develops from paired structures that fuse in midline. The two vocal cords meet in the midline and are connected at the level of anterior commissure tendon. This tendon forms a barrier to tumor spread to the opposite cord.

The larynx contains elastic membrane that lies between laryngeal mucosa and paraglottic space, thus forming an important barrier in preventing paraglottic spread of laryngeal malignancy. The superior portion of this membrane is known as the quadrangular membrane. This membrane forms the supraglottic barrier. It runs from the lateral part of the epiglottis posteriorly to the arytenoids. It extends inferiorly to the level of the ventricle.
The inferior portion of this elastic membrane is known as conus elasticus. It extends from the inferior surface of the thyroid cartilage anteriorly and the vocal process of arytenoid cartilage posteriorly. It extends up to the superior border of cricoid cartilage. The conus elasticus forms a definitive boundary between glottic and Subglottic regions.
Laryngeal ventricles separate the glottic region from the supraglottic region. For tumor to spread from the Supraglottis to the glottis or vice versa it must first extend deeply into the lateral angle of the laryngeal ventricle adjacent to the ala of thyroid cartilage and then extend vertically.

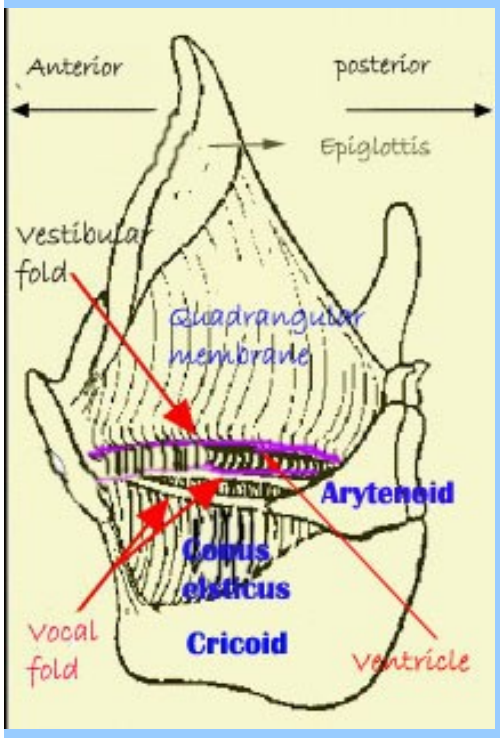


Diagram showing various membranous barriers of larynx

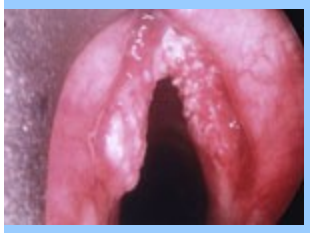
Cartilage invasion usually occur in areas of ossification. This easy breach of ossified cartilage has been attributed to vascularization of the cartilage. Cartilage invasion by tumor cells are usually preceded by resorption due to osteoclasts / chondroclasts. How and why this occurs is still unclear.

Glottic cancer

Glottic cancer is defined as malignancy involving the true vocal cords / anterior commissure / posterior commissure. Squamous cell carcinoma is the commonest malignant lesion affecting the vocal cord.

Glottic cancers are the most common laryngeal malignancy constituting 56%. The glottic region has very little lymphatic supply. Therefore there is less risk of early lymphatic spread of malignancy from this area. Early glottic carcinoma is usually confined to the vocal cord. Breach into the Reinke's space will allow the tumor to involve the entire extent of the vocal cord.
Involvement of vocalis muscle / cricoarytenoid joint by the tumor mass may cause fixation of the cord. Anterior progression of glottic tumor along the Broyle's ligament (anterior commissure tendon), vocalis tendon allows for early invasion of thyroid cartilage at the site of insertion of the ligament. This fact could account for a small glottic cancer to be classified as stage IV tumor because of involvement of thyroid cartilage.

Lateral spread of tumors from glottis may involve the paraglottic space. Only after involving the paraglottic space the glottic tumors can extend into the supraglottic / Subglottic areas.



Picture showing glottic growth involving both cords

Sites commonly involved in glottic carcinoma:

Commonly glottic carcinomas originate from the free margin of the anterior half of the vocal cord and the anterior commissure. It should be borne in mind that this is the most vibrating portion of the vocal cord. Tumors involving this region commonly remain confined to the vocal folds because of the presence of various barriers that thwart tumor invasion. These barriers must first be breached for progression to occur.

Spread of glottic cancer: Spread of glottic tumors tends to be slow and predictable. Initially it spreads along the free margin of the vocal cord towards the anterior commissure. Since even minor abnormalities of vocal folds cause hoarseness of voice, hoarseness of voice is an early feature in these patients. This not only disturbs the patient but also helps in early diagnosis of the disorder. Anterior commissure tendon presents the first barrier that delays the spread of the lesion to the opposite cord. This tendon hence temporarily slows down the progression of the tumor. Conus elasticus forms the second barrier as it slows down the tumor progression into the Subglottic region. This membrane contains the growth within the glottic compartment. Until Subglottic extension occurs, the chances of opposite hemilarynx being affected / metastasis to cervical nodes are pretty rare.
Invasion of the underlying thyroarytenoid muscle eventually occurs, causing fixation of the affected vocal cord. Tumor may extend along the muscle bundles anteriorly or posteriorly, and may reach lateral to the arytenoid cartilage coming into contact with the pyriform fossa mucosa involving it. This invasion is difficult to access by conventional laryngoscopic / radiologic procedures. This is where CT scan plays a role in accurate estimation of tumor involvement. Widening of thyroarytenoid space indicates such tumor spread.
Glottic tumors may also extend laterally to the conus elasticus and can escape via the cricothyroid triangle. This triangle is bounded by the cricothyroid membrane, thyroid cartilage, and the medial edge of cricothyroid muscle.

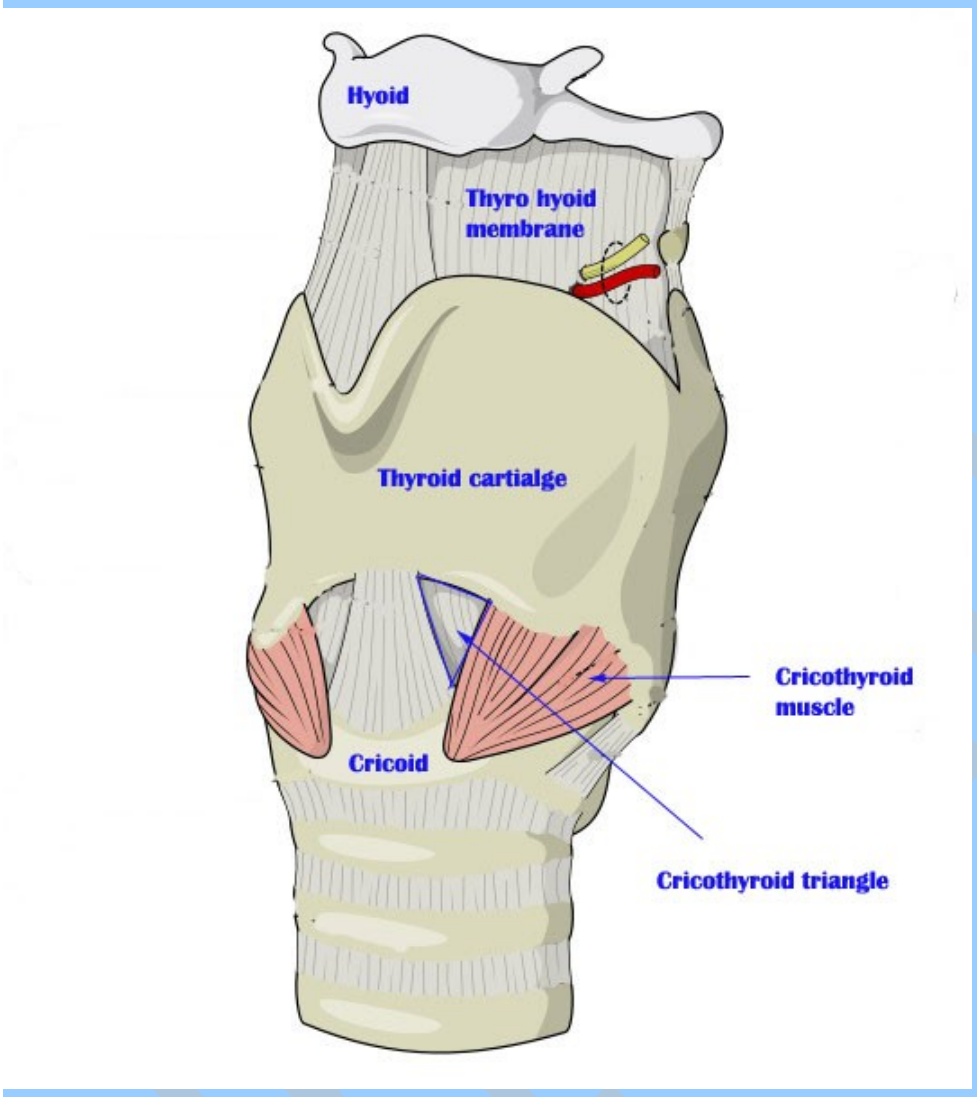


Figure showing cricothyroid triangle

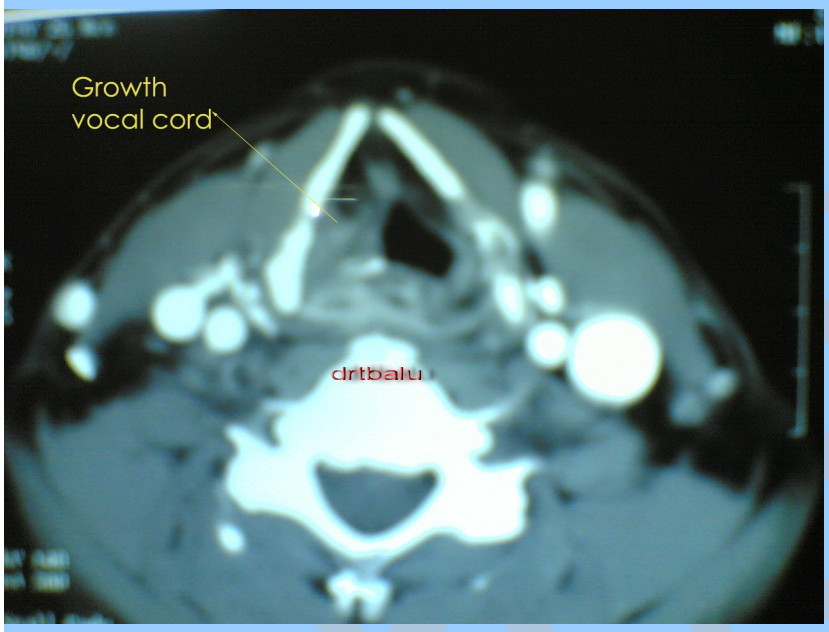
Clinical features of glottic growth:

- **Persistent hoarseness of voice. Even small lesions of the cord may cause significant hoarseness of voice, and these patients usually seek medical attention at a very early stage itself.**
- **Larger lesions of vocal cords may cause stridor.**
- **Rarely these lesions may cause haemoptysis**
- **In advanced stages cervical lymph node metastasis could also be seen.**
- **Indirect laryngoscopic examination will not only help in visualizing the lesion but would also help in assessing the mobility of the vocal cords. A fixed cord always indicates advanced lesion.**

Biopsy:

Biopsy of the lesion usually helps in confirming the diagnosis.

CT scan of larynx will clearly demonstrate the extension of the lesion and its spread.



Picture showing growth vocal cord

Histology:
Commonest malignant tumor involving glottic area happens to be squamous cell carcinoma. Other rare malignant tumors include: lymphoma, spindle cell carcinoma, minor salivary gland carcinomas, sarcomas, and mucosal melanomas.

Staging of glottic cancer:

Staging of laryngeal malignant growth helps in deciding the optimal treatment modality and prognosis.
American Joint Committee on Cancer staging is the most accepted staging modality.

T_X: Primary tumor cannot be assessed
T_0: No evidence of primary tumor
T_{is}: Carcinoma in situ

T_1: Tumor limited to vocal cords with normal mobility

T_{1a}: Tumor limited to one vocal fold

T_{1b}: Tumor involving both vocal folds

T_2: Tumor extending to Supraglottis or Subglottis areas with impaired vocal cord mobility

T_3: Tumor confined to larynx with fixity of vocal cord

T_{4a}: Tumor invasion through thyroid cartilage and / or with direct extralaryngeal spread

T_{4b}: Tumor invading the prevertebral space, encasing carotid artery, or invading mediastinal structures.

Regional nodes:

N_x: Regional nodes not assessed

N_0: No regional metastasis

N_1: Metastasis to 1 ipsilateral cervical node equal to or less than 3 cm in the greatest dimension

N_{2a}: Metastasis to 1 ipsilateral cervical node more than 3 cm but less than 6 cm in the greatest dimension.

N_{2b}: Metastases to multiple ipsilateral cervical lymph nodes, none greater than 6 cm in greatest dimension

N_{2c}: Metastases to bilateral or contralateral cervical lymph nodes, none more than 6 cm in greatest dimension

N_3: Metastases to any node(s) greater than 6 cm in greatest dimension

Distant metastasis:

M_x: Distant metastasis cannot be assessed

M_0: No distant metastasis

M_1: Distant metastasis present

Staging:

Stage 0: Tis, N0

Stage I: T1, N0

Stage II: T2, N0

Stage III: T1, N1 or T2, N1 or T3, N0-1
Stage IVa: T1-4a, N2

Stage IVa: T4a, N0-1, M0

Stage IVb: T4b, any N, M0

Stage IVb: Any T, N3, M0

Stage IVc: Any T, any N, M1

Causes of vocal cord fixation
1. **Vocal cord fixation may be caused due to deep invasion by the tumor with involvement of atleast the thyroarytenoid muscle** 2. **In cases where tumor invades the posterior part of vocal cord, fixation can occur due to involvement of the cricoarytenoid joint, cricoid cartilage or arytenoid or a combination of these.** 3. **Perineural invasion can cause paralysis of the affected cord.**

Management of glottic malignancy:

1. **Securing the airway if the patient is in stridor. This can be achieved by performing a tracheostomy.**
2. **Confirmation of the diagnosis by performing direct laryngoscopy biopsy.**
3. **CT scan neck to look for cervical metastasis.**
4. **X-ray chest**

Irradiation:

Irradiation is the primary non surgical treatment modality available for early glottic lesions (T1 and T2 lesions). Standard dose of radiation used in glottic tumors is a total of 60-70 Gy administered in single daily 2 Gy fractions over 6 weeks. Major advantage of irradiation is that cure rates are excellent with the preservation of voice in early lesions.
Radiation therapy with cetuximab, a monoclonal antibody against the epidermal growth factor receptor, has been shown to be more effective than radiation alone.

Disadvantages of radiotherapy:

1. **Long treatment course**
2. **Potential complications of irradiation**
3. **Difficulty in diagnosing recurrent lesions after irradiation**

Irradiation will really do wonders under the following conditions:

1. **Low volume tumors (Tumors less than $3cm^{3)}$ do the best.**
2. **Mobile cord.**
3. **No involvement of ventricle**
4. **No deep ulceration**
5. **Lack of supraglottic / Subglottic spread**
6. **Involvement of only one site**
7. **Patient should stop smoking**

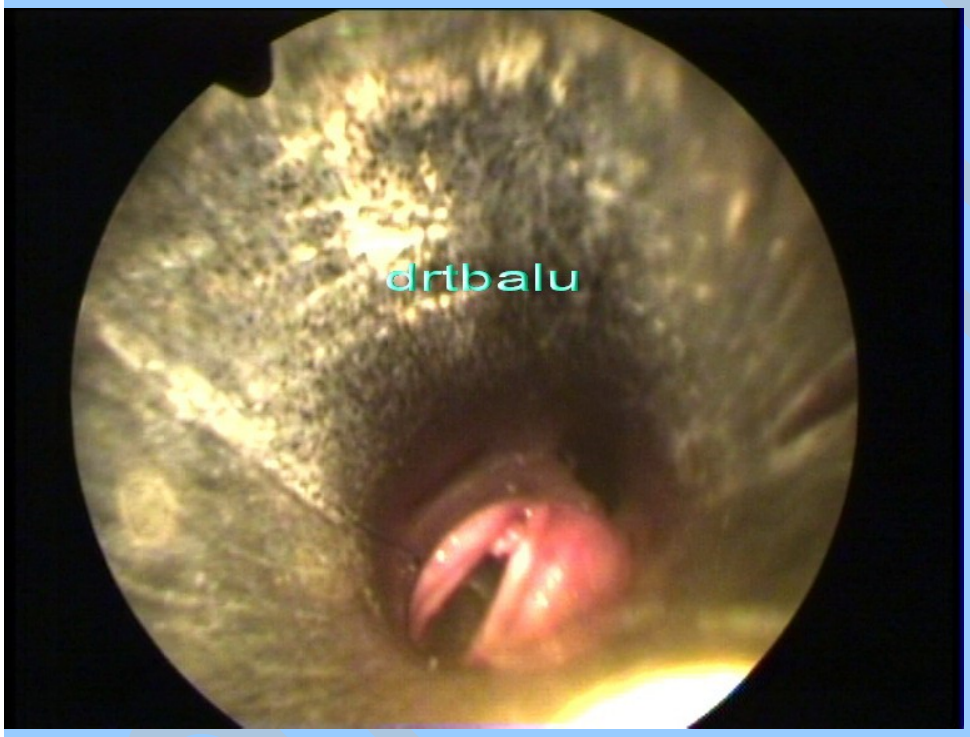
Chemotherapy:

A number of useful drugs are available with excellent activity against squamous cell carcinoma. Commonly used chemotherapeutic agents include: cisplatin, carboplatin, 5-fluorouracil, methotrexate, paclitaxel, docetaxel, and ifosfamide. Toxicity is greatly reduced when a single agent is used. Major response rates have been achieved in patients treated with cisplatin based combination therapy. Response rates improve in patients with previously untreated loco regionally advanced disease. Chemotherapy has been largely used as a palliative therapy in patients with advanced laryngeal malignancy.
Induction chemotherapy can be used to identify those patients who would benefit from irradiation.

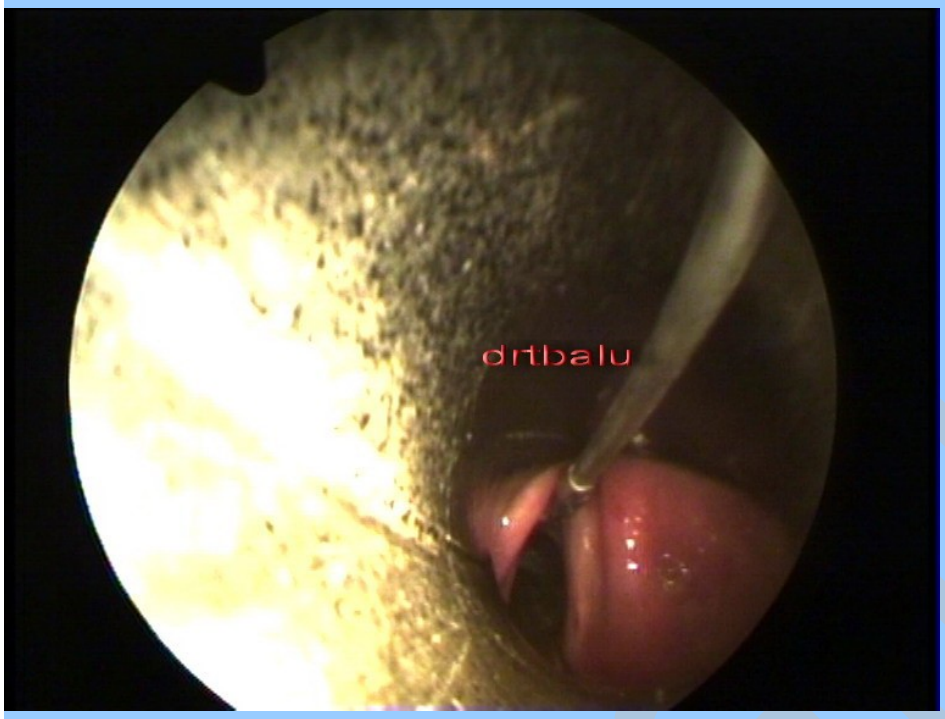
Surgical therapy:

Surgery is indicated in:

1. **Patients suffering from premalignant / carcinoma in situ lesions of vocal cords. Irradiation is contraindicated in these patients because of the risk of malignant transformation. Surgical procedure used in these patients is stripping of vocal cords, micro laryngeal excision of tumor mass etc. Carbon dioxide lasers can be used to remove these masses. Major advantage of laser therapy is that it causes minimal scarring of vocal folds, hence the voice becomes normal / near normal.**
2. **Stage III and IV lesions which need to be salvaged by surgery.**

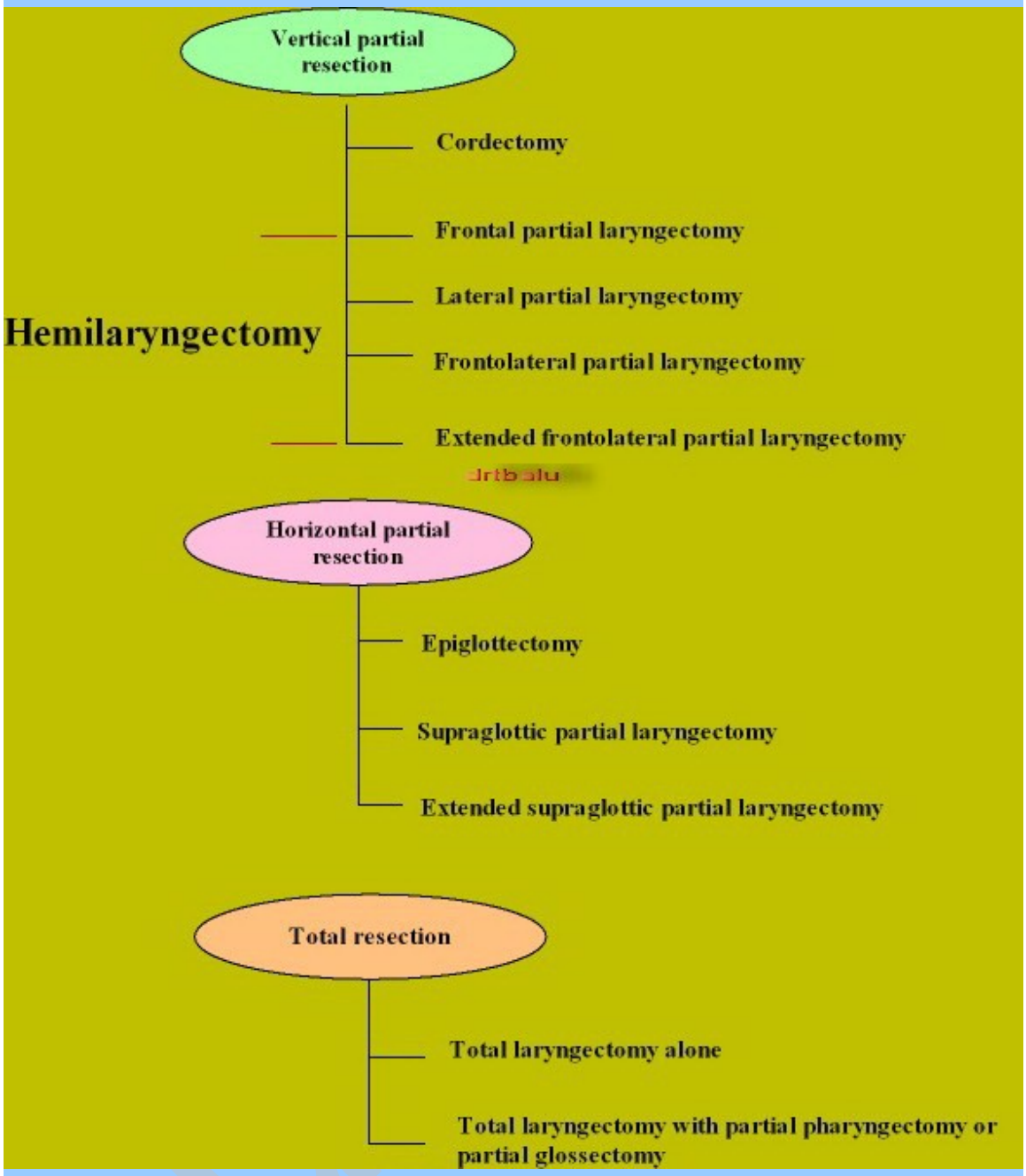


Early malignant lesion seen in the right vocal cord



Early lesion of right cord being removed

Types of laryngectomy:



Cordectomy: This surgical procedure involves removal of part / whole of the involved vocal cord. This surgery is performed under general anesthesia. A Kleinsasser suspension laryngoscope is used to expose the vocal cords. Part of the affected vocal cord / full cord can be excised using micro laryngeal instruments / laser.

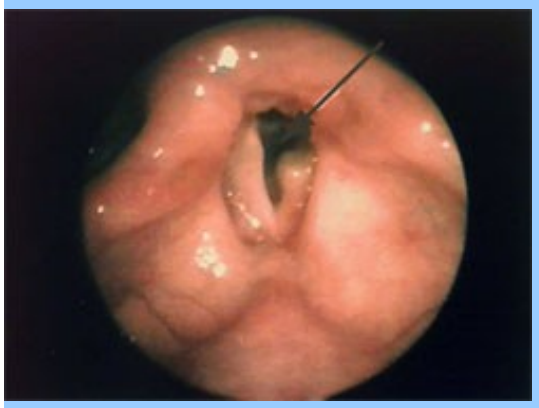


Figure showing portion of cord after excision

Cordectomy can also be performed via laryngofissure approach. This surgical procedure is now reserved for small lesions confined to the membranous portion of a mobile cord.

Laryngofissure: In this procedure the larynx is opened via a transverse neck incision.

Indications: Stage T1 carcinoma involving the free margin of the anterior portion of vocal cord. This lesion can also be accessed via laryngoscope.

Procedure:

- **Patient is positioned in a supine position.**
- **Preliminary tracheostomy is performed under local anesthesia.**
- **Endotracheal tube is inserted through the tracheostome.**
- **Transverse skin incision is made in the neck close to the lower border of thyroid cartilage. This incision site should be separate from that of tracheostome.**
- **Cervical flaps are elevated in the subplatysmal plane up to the level of hyoid bone superiorly and cricoid cartilage inferiorly.**
- **Strap muscles are incised in the midline.**
- **Perichondrium of the thyroid cartilage is incised in the midline and at the superior and inferior thyroid ala.**
- **Oscillating saw is used to cut the thyroid cartilage in the midline.**
- **Cricothyroid membrane is incised at the lower border of thyroid cartilage but only in the midline.**
- **This incision is carried superiorly through thyrotomy upwards dividing the anterior commissure / vocal cord of the same side just proximal to the anterior commissure. Care is taken not to cut through the mass.**
- **Tumor is resected along with a portion of the affected cord. Inner Perichondrium is also included in the specimen.**

- **Free edges of laryngeal mucosa are approximated using 4-0 chromic catgut.**
- **Laryngofissure is closed using 2-0 vicryl sutures.**
- **Perichondrium is closed using 3-0 vicryl sutures.**

Complications:

- **Hoarseness of voice**
- **Incomplete tumor resection**
- **Aspiration**
- **Post op oedema**
- **Laryngeal stenosis – This can be prevented by stenting the larynx using silastic keel and leaving it in place for 6 weeks.**
- **Polyp formation – If arytenoid is cut, especially in an irradiated patient, odematous mucosa may form in that area leading on to polyp formation. If large it should be removed by direct laryngoscopy.**

Oscillating saw being used to cut the thyroid cartilage

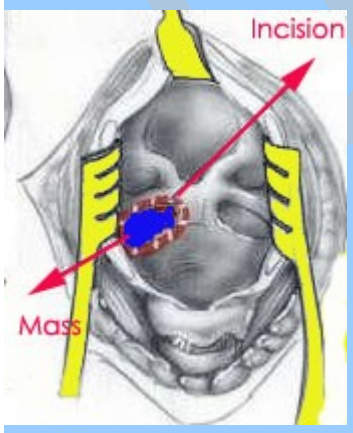


Figure showing the mass being exposed via laryngofissure approach

Vertical partial laryngectomy: Also known as lateral partial laryngectomy. This procedure is often termed as laryngofissure approach. This procedure is becoming less popular these days because of improved results following irradiation. This procedure still has its place in the management of T1 / T1a lesions in places where irradiation facilities are not that advanced.

Indication:

1. **This procedure is primarily indicated in patients with T1 lesions affecting one vocal cord. This lesion should not extend into the anterior commissure or on to the arytenoid cartilage.**
2. **It is also used to remove large benign tumors involving the larynx.**
3. **Front lateral partial laryngectomy may be useful in those patients in whom the glottic tumor crosses the anterior commissure to involve the anterior third of the opposite cord. The cords should be mobile. (i.e. Horse shoe tumor.)**
4. **There should be no more than 5 mm of Subglottic spread.**
5. **There should be no supraglottic / transglottic extension**
6. **There should be no involvement of more than 1/5 – 1/3 of the contralateral cord.**
7. **Arytenoids should be free of disease**
8. **Patient's age and general condition should also be taken into account.**
9. **Adequate pulmonary function is a must.**

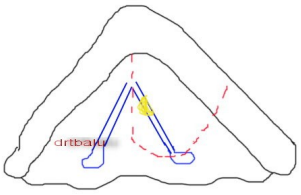
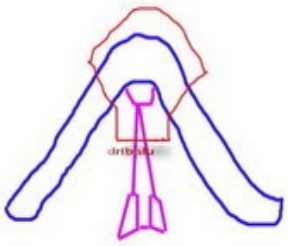


Image showing the area of resection in frontal partial laryngectomy (transverse section)

Types of frontal partial laryngectomy:



Frontal partial laryngectomy

Frontolateral partial laryngectomy

Extended frontolateral partial laryngectomy

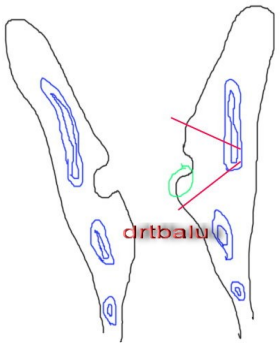


Image showing coronal section of the areas involved in vertical partial laryngectomy

Figure showing the areas to be resected in front lateral partial laryngectomy

*** Consent for total laryngectomy should always be obtained before performing any partial laryngectomy surgery.**

*** Oral hygiene of the patient must be first improved before taking up for surgery.**

*** Focal sepsis if present in the nasal cavity should be treated before surgery.**

*** Consent for tracheostomy should be secure before surgery.**

Aim of vertical partial laryngectomy:

- **Tumor must be entirely removed in one piece.**
- **The resected margin should be wide**
- **Tumor margin should atleast be 0.5cm**

Procedure:

1. **Transverse skin incision is made over the upper border of cricoid cartilage.**
2. **Tracheostomy incision is usually sited at a slightly lower level.**
3. **Strap muscles are separated.**
4. **The isthmus of thyroid gland is divided.**
5. **The thyroid ala is excised by first separating the outer Perichondrium as far as the oblique line. The sectioning of thyroid cartilage is performed using a saw in the midline and laterally.**

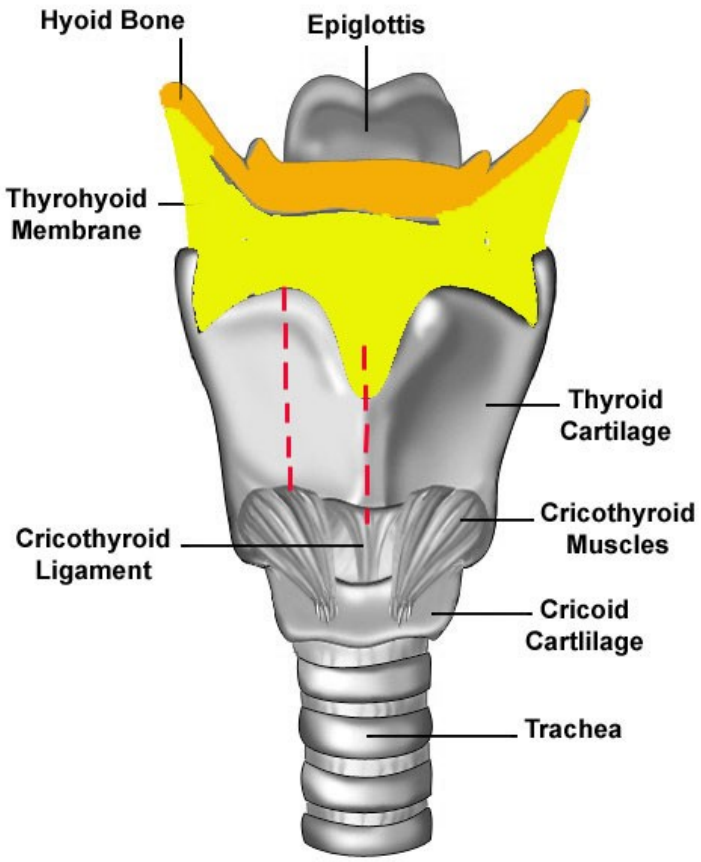


Image showing the two thyroid cuts in red

6. **The tumor along with the involved cord, ventricular band is excised.**
7. **After securing perfect hemostasis, sternohoid muscle is placed inside the preserved outer Perichondrium to reduce the dead space.**

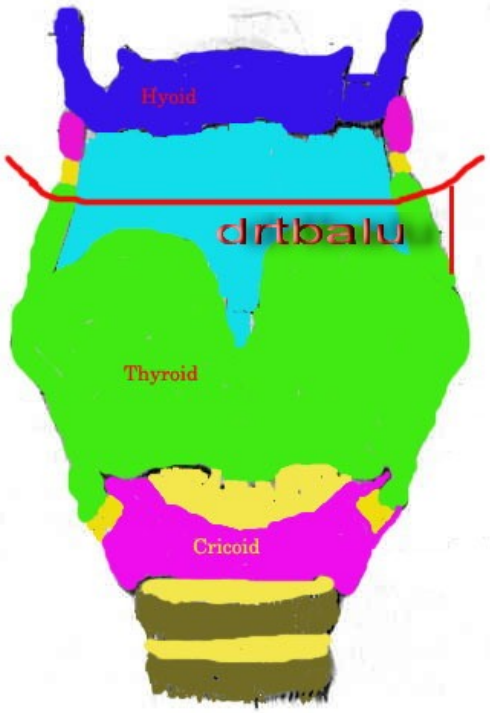
Supraglottic partial laryngectomy:

This surgical procedure is used to remove supralaryngeal malignant tumors. This has also the added advantage of preservation of voice.

Indications:

1. **No vocal cord involvement**
2. **Normal cord mobility**
3. **No evidence of cartilage destruction**
4. **No paraglottic involvement**
5. **Pre epiglottic space should be free**
6. **Absence of tongue base involvement**
7. **Good cardiopulmonary reserve**
8. **Not ideal in an irradiated patient**

Incision: T shaped neck incision described by Som. A simple transverse skin crease incision may also be preferred.



Som's T shaped incison

Preliminary tracheostomy should be performed. This has the added advantage of post operative airway control.

Supra laryngeal exposure:

Skin flaps are elevated in the subplatysmal plane. This is done to keep the blood supply to the flap intact, facilitating better healing.

Strap muscles are divided on both sides at the level of superior border of thyroid cartilage and are turned down. The hyoid bone, superior cornua and posterior borders of thyroid cartilage are defined at this stage.

If neck dissection is necessary it should be performed at this stage.

In the midline, the lower border of thyroid cartilage and the thyroid notch are identified. The distance between these two points is measured and the mid point is marked using methylene blue. Usually this point marks the position of anterior commissure in men. In women the anterior commissure lies at a slightly higher level. From this point a horizontal line is marked along the thyroid cartilage parallel to its inferior border. This is the point of cartilage incision. This incision line on reaching the posterior border of thyroid cartilage is continued upwards in a perpendicular direction along the posterior border of the cartilage.

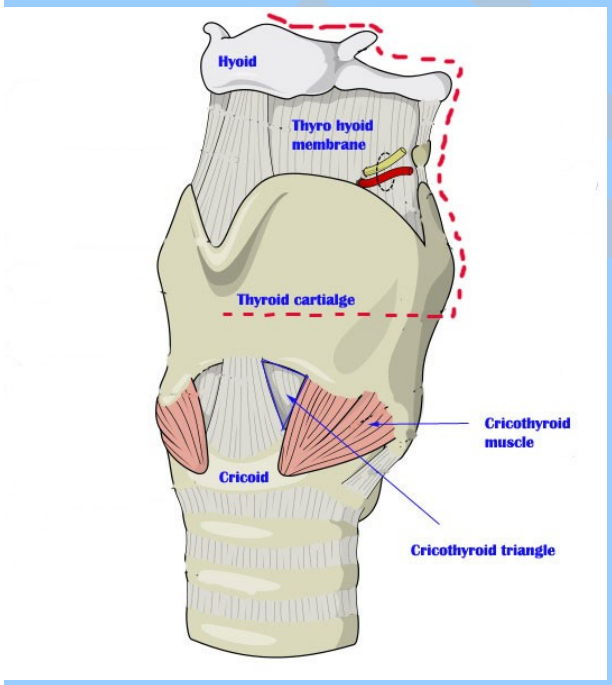


Figure showing cartilage incisions

Incision is performed along the incision line indicated in the diagram. The Perichondrium of thyroid cartilage is cut along its upper edge and is elevated

downwards towards the incision mark. The Perichondrium should not be torn in the process of elevation. With the help of a fissure burr / saw, the thyroid cartilage is divided as indicated along the line of incision.

- **The cartilage alone is divided keeping the laryngeal mucosa intact.**

Both sides of thyroid cartilage are divided. Muscles attached to the upper border of hyoid bone are also divided. The superior thyroid vessels are divided and transfixed on one or both sides depending on the extent of resection.

Tumor removal:

For this the surgeon will have to migrate to the head end of the patient. Surgeon may need to wear a headlight during this phase of dissection. Scissors is used to make an entry into the valleculae. This is done just above the hyoid bone, on the side of neck dissection. If the tumor is present in the valleculae then pharynx will have to be entered through the pyriform fossa. Tongue base is retracted and epiglottis is held forwards with the help of Allis forceps.

Ventricles should be seen necessarily at this stage. The arytenoids are retracted by an assistant with the help of hooks. One blade of the scissors is placed inside the ventricle superior to the vocal cord and the other blade outside the thyroid cartilage opposite to the cartilaginous incision. The cuts are carried forwards through the ventricles and the specimen along with (neck dissection if performed earlier) should be removed in continuity.

In the presence of tumor epiglottis, then each aryepiglottic fold should be divided immediately anterosuperior to the arytenoid cartilage, well clear of tumor. If the tumor involves the aryepiglottic fold, the uninvolved side is divided above the arytenoid cartilage, while the incision is made through the cricoarytenoid joint on the involved side. These are some of the modifications that can be made to supralaryngeal dissection depending on the location and extent of growth.

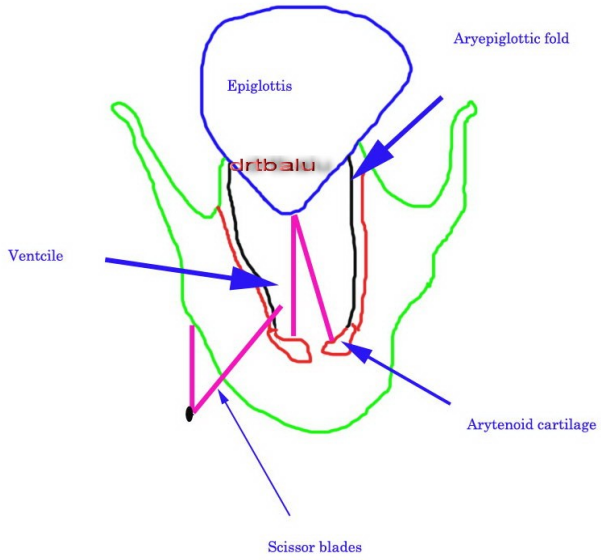


Figure showing line of division through ventricle

Cricopharyngeal myotomy: This is the next step. Here the cricopharyngeas muscle is divided. This step if not performed may cause Dysphagia at a later date due to cricopharyngeal muscle spasm. The surgeon passes his finger through the cricopharyngeas muscle into the oesophagus. Muscle fibers are cut through as far as the mucosa till the upper part of oesophagus feels lax. This myotomy is carried out posteriorly to avoid damaging the recurrent laryngeal nerve.

Pharyngeal repair: Before beginning to repair the wound a naso gastric tube should be introduced. It is really worthwhile performing a patient pharyngeal repair. This will really help in reducing the incidence of post operative fistula formation. It is mandatory to secure perfect hemostasis in this area. Raw surfaces if any should be left to heal by second intention. Any attempt made to close the wound gap in this area with mucosal flaps will lead to laryngeal immobility due to fibrosis.
Pharynx is closed in three layers. The first layer is closed under some tension using 2/0 Vicryl. The second layer is also closed with 2/0 Vicryl (tongue base to the thyroid cartilage Perichondrium). The skin wound can be closed using silk / staples.

Complications:

- **Aspiration**
- **Fistula**
- **Post op oedema**
- **Air way obstruction**

Near total laryngectomy / Laryngopharyngectomy:

This surgery is performed for T_3 carcinoma of larynx. This technique is essentially an extended hemilaryngectomy where in one half of the larynx is completely removed together with about 2/3 of the other side, leaving only an arytenoid on the affected side. This procedure effectively removes both paraglottic spaces. This procedure is very useful in managing highly lateralized laryngeal cancers involving the pyriform fossa.

Indications:

1. **Lateralized glottic / transglottic cancers with impaired vocal cord mobility, for which vertical partial / supracricoid partial laryngectomy would not be safe.**
2. **Lateralized supraglottic or aryepiglottic fold cancers with impaired movement where other partial laryngeal surgeries may not be useful.**
3. **Most of supra glottic cancers in patients physiologically unfit for supra glottic partial laryngectomy**
4. **Pyriform fossa malignancy**

Procedure:

In this surgery, the entire larynx is removed from tongue to trachea, leaving a narrow posterolateral column of uninvolved Subglottic, arytenoid and pyriform tissue. Voice is generated by a dynamic tracheopharyngeal myomucosal shunt. This shunt is usually built from:

1. **Column of innervated soft tissues remaining after surgery**
2. **Small rotation flap from ipsilateral pharynx**

Exposure and transaction of strap muscles: Dissection of neck begins by exposing the strap muscles of neck on the side of the tumor. The strap muscles are transected low, exposing the ipsilateral thyroid lobe. The contralateral strap muscles are preserved. Hemithyroidectomy is performed on the side of the lesion.
Supra hyoid muscles are cut free to release the hyoid bone. The column of larynx to be preserved for the shunt lies on the side of least tumor involvement.

Wedge thyroidotomy: A middle column or wedge of tissue is removed from the ala of thyroid cartilage on the conserved side after releasing the sternohyoid muscle and dividing the hyoid bone. The body of the hyoid stays with the specimen. A periosteal elevator is introduced under the deep surface of the middle 1/3 of the thyroid ala, beginning at the superior margin to prepare the overlying wedge of cartilage for removal. Care should be taken not to traumatize the underlying thyroarytenoid muscle, or entering into the ventricle that lie just above it.

Ventriculotomy: The laryngeal lumen is entered through the fibroglandular tissue that caps the ventricle on the uninvolved side. The edges of the ventricle are retracted with hooks and the larynx is entered. The resection line is then directed towards the tumor side and the vallecula is transected. The specimen can now be folded forwards and the whole of endolaryngeal cavity becomes visible. The surgeon can now decide where exactly to transect the good cord.

Glottic resection: After determining where the good cord can be transected the surgeon starts to cut downwards from that area into the anterior Subglottis. The posterior cricoid plate is cut in midline and broking open the cricoid ring. The interarytenoid muscle is divided. The specimen now only attached with pharyngeal mucosa is removed. Residual cricoid cartilage is removed by submucosal resection. Care should be taken to retain the recurrent laryngeal nerve atleast on one side.

Reconstruction with composite stent: The laryngeal remnant should be sufficient to reconstruct a tube of atleast 14 French gauge width. The flap and laryngeal remnant are united in parallel to create the posterior wall. The composite is tubed, and the anterior wall is completed by suturing the edges vertically. A 14 French gauge catheter can be used to gauge the diameter of the tube. This tube is further strengthened with the addition of muscular elements to form thyroarytenoid – interarytenoid sphincter.
The pharyngotomy is closed. Wound is closed after leaving a drain.

Contraindications:

1. **Failed irradiation / partial laryngectomy**
2. **Tumors involving both ventricles.**
3. **Primary Subglottic cancers**
4. **Posterior cancers / postcricoid growths**

Supracricoid partial laryngectomy:
Even though this surgery is performed after tracheostomy, unlike near total laryngectomy the aim is restoration of speech and swallowing without permanent tracheostomy.

In this surgical procedure the following portions of the larynx are completely removed:

- **True and false vocal cords**
- **Both paraglottic spaces**
- **Entire thyroid cartilage**
- **Involved arytenoid**

Reconstruction is complete only after completion of cricohyoidoepiglottopexy. This surgery can be a useful alternative to total laryngectomy.

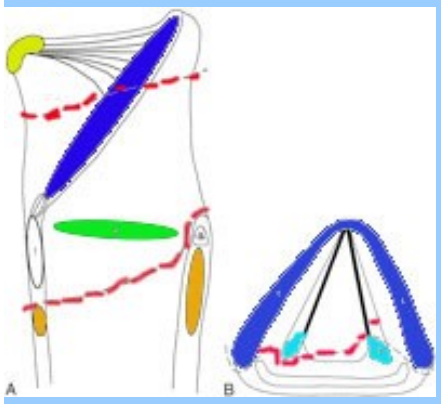
Indications:

- **Bilateral cord involvement with / without anterior commissure involvement (horse shoe tumor).**
- **Unilateral glottic carcinoma with anterior commissure involvement.**
- **Cord involvement with impaired mobility**
- **T_3 glottic lesion with fixed cord**
- **Supraglottic lesions with involvement of ventricle, vocal cords with impaired mobility.**
- **T_4 lesions with limited thyroid cartilage invasion**

Procedure:

The incision preferred is transverse skin crease incision. Subplatysmal skin flaps are retracted. Larynx is entered with scissors just above the thyroid notch. Since the entry is above the level of false cords the whole of epiglottis and preepiglottic space is spared. Efforts are made to preserve the arytenoid on the non involved side. With one scissor blade inserted between the inner aspect of the thyroid cartilage and the internal thyroid Perichondrium, the false cord is transected where it meets the arytenoid. The excision is extended posterior to the ventricle and through the vocal process of the true cord to the level of the cricoid. The line of transaction is continued anteriorly through the cricothyroid musculature along the top of the cricoid cartilage. Cricothyroitomy is performed to free the thyroid cartilage from cricoid cartilage. The larynx is cracked open on itself like a book, and the resection on the involved side is performed along the cricoid, taking the involved arytenoid as necessary. The posterior arytenoid mucosa must be spared on the involved side. The remaining arytenoid and posterior arytenoid mucosa are sutured anteriorly to the level of the cricoid.

Closure is performed by placing 3 pexy sutures around the cricoid and passed through the epiglottis, preepiglottic space, around the hyoid, and deep into the tongue base. The cricoid and hyoid bones are thus approximated.



Resection lines of supracricoid partial laryngectomy marked in red

Tips:

1. **The neck flap (subplatysmal) is elevated up to 2cms above the hyoid bone to prevent tethering of skin during reconstruction.**
2. **Infrahyoid muscles are incised at the superior border of thyroid cartilage**
3. **Supra hyoid muscles should be spared, since the vascularity of hyoid bone may become compromised.**
4. **Blunt finger dissection in the area of cervico mediastinal trachea helps to reduce tension during reconstruction.**
5. **Cricoarytenoid unit on the uninvolved side should be preserved as it is very vital for the post operative voice function.**
6. **Main trunk of superior laryngeal nerves should be spared as it is vital for sensation of post op larynx.**
7. **Cricothyroid joints should always be articulated in the subperichondrial plane. This will help in preserving the recurrent laryngeal nerve.**
8. **After removing the arytenoid on the involved side, posterior arytenoid mucosa should be preserved. This will help in early restoration of swallowing function in these patients.**
9. **Posterior third of false and true vocal cords should not be preserved, as it could compromise the approximation of the arytenoid to the tongue base.**
10. **Cricopharyngeal myotomy should be performed if palpation of the upper esophageal sphincter reveals hypertonia. History of GERD is a contraindication for this procedure.**
11. **The tracheostomy site is made in line with the neck incision to facilitate replacement of the tracheostomy tube if it becomes dislodged in the perioperative period. If the tracheostomy tube becomes dislodged, air could potentially track above the tracheostomy site, forming a dead space. This can be prevented by obliterating the space anterior to trachea during surgery. This can be achieved by resuturing the thyroid isthmus, as well as including a portion of thyroid tissue within the vertical midline closure of strap muscles.**

Contraindications:

This surgical procedure is contraindicated in:

1. **Tumors originating from anterior commissure / ventricle with propensity for early pre epiglottic space involvement.**
2. **Glottic tumors with involvement of cricoarytenoid joint.**
3. **Glottic tumors with Subglottic extension.**
4. **Tumors of glottis invading the posterior commissure**
5. **Tumors of glottis with extra laryngeal spread**
6. **Interarytenoid area involvement**

Complications:

1. **Aspiration**
2. **Wound infection**
3. **Hematoma**
4. **Laryngocele**
5. **Ruptured pexis**
6. **Chondronecrosis**
7. **Laryngeal stenosis**
8. **Stomal recurrence**

Total laryngectomy: This surgical procedure involves removal of the entire larynx with creation of permanent tracheostomy to facilitate respiration. This surgery was first performed by Billroth of Vienna in 1873 as treatment for laryngeal cancer.

Indications:

1. **Stage T_3 and T_4 carcinoma of larynx**
2. **Stage T_2 carcinoma unsuitable for partial laryngectomy**
3. **Subglottic carcinoma / glottic carcinoma with subglottic extension of more than 1.5 cms**
4. **Failed radiotherapy for laryngeal carcinoma**

Procedure:

This procedure is ideally performed under general anesthesia. The endotracheal tube is led out over the head of the patient and the Boyles apparatus is positioned at the head end of the table. The skin of the whole of the neck, the lower half of the face and the chest up to the level of the nipples should be sterilized.

Towel drapes are securely stitched to the skin.

Incision: In deciding on the suitable neck incision the following points should be considered:

- **Whether the patient has under gone preoperative irradiation**
- **Whether a neck dissection should be performed along with total laryngectomy**

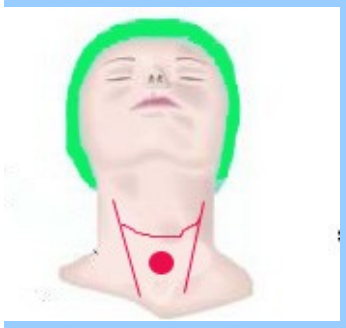
In an irradiated patient a low collar incision is preferred, and the tracheostome is brought out separately through the inferior flap. This helps in minimizing wound infections and ensures better wound healing in these patients. "H" incision should be avoided in these patients because it compromises the vascularity of the skin flap and prevent healing in these patients.

In non irradiated patient a Gluck Sorenson U-shaped incision can be resorted to. In this incision the tracheostome is included into the incision line. This incision can also be extended for neck dissection purposes. This extension is known as side arm extension. The major disadvantage of this side arm extension is the creation of a three point junction in the skin defect. This three point junctional area is difficult to heal.

Figure showing Gluck Sorenson incision

Gluck Sorenson incision with side arm extension

Classical Gluck Sorenson incision is a U shaped incision. The arm of the U extends from just below the angle of the mandible, along the anterior border of sternomastoid muscle on both sides. The horizontal limb of the incision is usually sited at the level of 3 / 4 tracheal rings including the stoma of tracheostome.



'H' shaped neck incision

The skin flap is elevated in the subplatysmal plane. Dissection in this plane causes the least damage to the vascularity of the skin flap. This flap is stitched out of the way. The medial border of the sternomastoid muscle is identified and the larynx is mobilized by dissecting in a plane medial to this muscle. In irradiated patients the internal jugular vein may be encountered early because it could be pulled forwards due to adhesions. The carotid sheath is identified and is retracted laterally.
The omohyoid muscle is divided and the underlying middle thyroid vein is ligated.
In the upper part of dissection the superior thyroid pedicle is identified and ligated.
Hypoglossal nerve should be identified and preserved. Damage to hypoglossal nerve can cause swallowing difficulties in post operative period.
Strap muscles are divided inferiorly just above the sternum and superiorly just above the hyoid bone. Hemithyroidectomy (in unilateral cancers) or total thyroidectomy (in bilateral lesions) may be performed. Dissection is continued through the fatty plane lateral to the trachea till it is fully exposed.

Suprahyoid dissection: in this phase of dissection, the hyoid bone is mobilized and its body is held with Allis forceps. Supra hyoid muscles are divided subperiosteally using traction counter traction technique. The base of tongue and pharyngeal mucosa is identified.

Tracheal division: The inferior thyroid veins are ligated and the trachea is divided between the third and fourth tracheal rings and the airway is secured. The cervical trachea is mobilized by dissecting in a plane between the trachea and oesophagus. Care should be taken not to mobilize in this plane too far as this could compromise the blood supply to oesophagus and trachea.

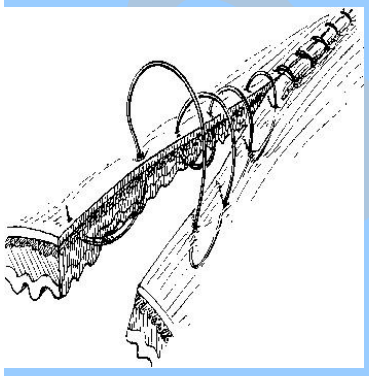
During this phase the anesthetist performs the tube change by removing the naso tracheal tube and passing it via the tracheostome. While performing tracheostomy, it is better to divide the trachea cleanly through the space between the tracheal rings. Making a stoma is an important step in this surgery. Chromic catgut / Vicryl sutures can be used to stitch the pretracheal fascia to the subcutaneous tissue in the lower skin flap. This leaves a small bit of excess trachea protruding above the level of skin.

Removal of larynx:

Removal of larynx can be performed from below upwards or above downwards. The above downwards approach has an important advantage i.e. the inside of the larynx can be seen and there is no danger of cutting into the tumor tissue.
The body of the hyoid bone is grasped with a heavy artery forceps. Using a cutting diathermy the surgeon cuts through the base of tongue and enters the pharynx on the side opposite to that of the tumor. Preepiglottic space should not be entered during this phase. The tip of the epiglottis is grasped with Allis forceps and pulled anteriorly and inferiorly. The surgeon now should stand at the head end of the patient. With the help of scissors the pharyngeal mucosa is cut laterally on each side of epiglottis aiming towards the superior cornu of the thyroid cartilage. The larynx is released by dividing the constrictor muscles along the posterior edge of the thyroid cartilage with cutting diathermy / scissors. The pharyngeal mucosa is then divided on each side in the region of superior cornu of the thyroid cartilage aiming downwards towards the posterior portion of the arytenoid cartilage. These two cuts are joined posteriorly inferior to the cricoarytenoid joint. There is a good plane of cleavage on the posterior cricoarytenoid muscle in this area.

Pharyngeal repair:

After removal of larynx, the wound is irrigated. The simplest and most effective way to repair the pharynx is to perform a straight line three layer closure. Ideally the closure is started from the lower end using 3-0 Vicryl suture material. Connel stitches are used (The suture goes through the wall from the serosa to the mucosa, then back from the mucosa to the serosa on the same side. The stitch then crosses the incision to the serosa on the other side and then repeats.). This type of stitches picks up the edges of the pharyngeal mucosa without piercing it. It also inverts the mucosal edges.



Connel suture

Alternatively "T" shaped repair can be attempted. This type of repair creates three point junctions which is poor surgical repair technique. In patients with short necks

and lots of redundant mucosa it may be possible to perform a transverse straight line repair.

Permanent tracheostome is performed.

Naso gastric tube is introduced.

Supraglottic growth

Supraglottic carcinomas constitute 40% of all laryngeal cancers.

Causative factors: Synergistic actions of alcohol and tobacco commonly affect the epilarynx (aryepiglottic fold and Suprahyoid epiglottis).
Most commonly Supraglottic carcinoma occurs in the infra hyoid portion of epiglottis.

Features of Supraglottic growth:

1. **These tumors nearly always invade the fenestra in the epiglottis**
2. **Nearly half of these tumors manage to invade the thyroid cartilage anteriorly or along its upper lateral edge**
3. **These tumors commonly invade the pre epiglottic space by destroying the thyroepiglottic ligament / spreading via the fenestra of epiglottis**
4. **Tumors involving the base of epiglottis almost never invade the paraglottic space it is thus safe to a horizontal Supraglottic partial laryngectomy.**
5. **Only a small proportion of these tumors extend inferiorly to invade the floor of the ventricle / vocal folds**
6. **Carcinomas of ventricular bands are very rare. But these tumors have a tendency to spread superficially on the mucosal surface to involve the laryngeal surface of epiglottis and the aryepiglottic fold**
7. **Supraglottic carcinomas may superiorly extend to involve the tongue base / vallecula**

Embryology:

Study of embryological origin will help us to clearly understand the tumor spread / behavior. Supraglottis is derived from the bucopharyngeal anlage of 3rd and 4th branchial arches while the glottic and subglottic areas are derived from the tracheobranchial anlage in the region of 5th and 6th arches. These areas since having different origin also have different lymphatic drainage pathways. These lymphatic pathways determine the tumor spread. It should also be pointed out that the

lymphatics are more dense in the supra glottic region when compared with that of glottis and subglottis. Early nodal metastasis is a feature of Supraglottic growths.

Symptoms:

1. **Hoarseness of voice**
2. **Odynophagia**
3. **Dysphagia**
4. **Neck mass**
5. **Haemoptysis**
6. **Chronic cough**
7. **Stridor**

Picture showing enlarged neck nodes

Subsites involved:

1. **Suprahyoid epiglottis**
2. **Infrahyoid epiglottis**
3. **False cords**
4. **Arytenoid**
5. **Aryepiglottic folds**

Histology:

The mucosa of the supraglottis is composed of nonkeratinizing, stratified, squamous epithelium. Inferiorly, at the level of the laryngeal aditus, this epithelium changes to ciliated, pseudostratified, columnar epithelium at the false folds and the ventricle.

Squamous cell carcinoma is common here. It can be classified into well differentiated, moderately differentiated and poorly differentiated carcinoma.

Staging of Supraglottic tumors: UICC classification

T – Primary tumor

T_{is} – Carcinoma in situ

T_1 – Tumor limited to one subsite of supraglottis with normal vocal cord mobility

T_2 - Invades mucosa of more than 1 adjacent subsite of supraglottis or glottis or region outside the supraglottis, without fixation of the larynx

T_3 – Tumor limited to larynx with vocal cord fixation and / or invades any of the following: postcricoid, Preepiglottic tissues and tongue base

T_4 – Tumor invades through thyroid cartilage / extends into soft tissues of the neck, thyroid / oesophagus

Nodal status:

N_0 – No nodal involvement
N_1 - Metastasis in a single ipsilateral node that is greater than or equal to 3 cm
N_{2a} - Metastasis in a single ipsilateral node more than 3 cm but not more than 3-6 cm in greatest dimension
N_{2b} - Metastasis in multiple ipsilateral nodes with none more than 6 cm in greatest dimension
N_{2c} - Metastasis in bilateral or contralateral nodes, none more than 6 cm in largest dimension
N_3 - Metastasis in a lymph node that is larger than 6 cm in greatest dimension

Distant metastasis:

M_0 – No metastasis
M_1 – Distant metastasis

Stage:

Stage 0 – T_{is} N_o M_o
Stage I – T_1 N_o M_o

Stage II – T_2 N_0 M_0
Stage III – T_3 N_0 M_0
T_1 N_1 M_0
T_2 N_1 M_0
T_3 N_1 M_0

Stage IVa – T_{4a} N_0 M_0
$T4_a$ N_1 M_0
T_1 N_2 M_0
T_2 N_2 M_0
T_3 N_2 M_0
T_{4a} N_2 M_0

Stage IVb – T_{4b} Any N M_0
Any T N_3 M_0

Stage IVc – Any T Any N M_1
Management of supraglottic cancers:

Irradiation: Stage I cancers in this area is amenable to irradiation. Complete curative dose should be administered (total of 60 – 70 Gy) administered within 6 weeks.

Surgery: Stages II and III lesions respond to supraglottic partial laryngectomy / with or without neck dissection.

Stage IV lesions need total laryngectomy with neck dissection.

Elective neck dissection: Since occult lymph node metastasis is common in supra glottic tumors more and more institutions resort to bilateral elective neck dissection for even Stage I tumors.

Subglottic cancers

This is the rarest of laryngeal cancers, constituting less than 5% of laryngeal malignancies. There are two types of subglottic cancers i.e.

1. **A tumor which arises primarily in the subglottic space**
2. **Tumor that arises on the under surface of vocal cords and extends into the subglottic space**

True subglottic tumors are usually unilateral, always ulcerative and fungating. This is in contrast to the exophytic growth found in the epiglottis.

Subglottic tumors invade the Perichondrium of thyroid and cricoid cartilages and frequently pass through the cricothyroid membrane to involve other areas of larynx.

Tumors of this area cause early fixity of vocal cords because it invades the intrinsic muscles of larynx at a fairly early phase. True subglottic cancers cause Stridor. This is in contrast with that of glottic tumors with subglottic extension which causes hoarseness of voice before causing stridor.

Subglottic tumors carry a bad prognosis.

Early tumors in this area can be managed by total laryngectomy / irradiation.

Advanced lesions cause paratracheal / mediastinal nodal metastasis. Patients with advanced lesions are best managed by palliative radiation.